Quantum Electrical Metrology Division
Electrical and Electronics Engineering Laboratory
Ac-dc Difference Standards and Measurement Techniques Project

Monthly Highlight Submission

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Category: Impact of NIST Research and Services

New, improved ac standards delivered to Department of Defense Laboratories

Thanks to researchers in the Quantum Electrical Metrology Division of EEEL, the primary standards laboratories of the Department of Defense now have the capability to measure ac voltage as well as many National Metrology Institutes. This dramatic improvement in measurement capability is made possible by the delivery of two thin-film multijunction thermal converters (MJTCs) each to the Air Force Primary Standards Laboratory in Newark, OH, and to the Army Primary Standards Laboratory at Redstone, AL. These MJTCs feature a heater structure deposited on silicon wafer with a top layer of silicon nitride. After 100 thermocouples are deposited alongside the heater, the area underneath the heater is etched away to increase thermal efficiency using deep reactive ion etching leaving an isothermal region on the membrane. An obelisk of silicon is left directly beneath the heater to improve the low frequency performance of the MJTC, and the chip itself is packaged in vacuum to further improve its sensitivity. Measurements on these MJTCs at NIST indicate that they are among the finest standards in the world for the measurement of ac voltage, with negligible ac-dc differences between 10 Hz and 20 kHz, and with small ac-dc differences up to 1 MHz. In addition, the ac-dc difference is independent of input voltage level from 2 V down to 150 mV, simplifying the range-to-range scaling. NIST is now beginning to use these devices as standards for ac-dc difference; the armed services laboratories will transition from their present primary standards to MJTCs. Since these MJTCs offer primary-standard performance in a robust working standard, the delivery of the MJTCs will permit these laboratories to reduce their uncertainties and increase the overall quality of their calibrations. These MJTCs were designed and fabricated as part of a collaboration between NIST and Sandia National Laboratories and were delivered under CCG Project 441.

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